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# [54] IMPROVED MOISTURE-RESISTANT COATING AND METHOD OF PRODUCING IT

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## [57] ABSTRACT

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## DETAILS

PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improved Moisture-Resistant Coating and Method of Producing it We, WESTERN ELECTRIC COM Pi ANY INCORPORATED, of 195, Broadway, New York City, New York State, 'United States of America, a Corporation of the State of New York, tnited States of America, do hereby declare the nature of this inven-tion and in -what manner the same is to be performed, to be particularly described and ascertained in and by the following statement: -

This invention relates to a coating pro-cess for producing a moisture-resistant coating on a metallic or non-mietallic sur-face.

In its preferred embodiment the inven-tion is particularly applicable to electrical devices such as transformers, retard coils and the like In protecting such a device from the adverse effects of moisture it

has generally been customary to place the device within a hermnetically sealed metal container filled Wvith a suitable potting colnpound However, there are many instances, such as in airborne or portable equipment, where the additional weight of the container and the potting compound and the resulting increase in size are objectionable.

It is an object of the present invention to provide such a device with an adherent moisture resistant coating which will maintain its characteristics over a wide temperature range.

According to the invention a method of forminm a smooth adherent moisture-resistant coating on a surface such as the external surface of an electrical device comprising a formed coil eoml)rises applying to the surface an impregnating coat-4 G ilng consisting of a polvinerizlable resin varnish, drying and baking said coatinlg until the varnish is substantially fully cure(, subsequently applying to the sur-face a final coating of a polynierizable resin varnislh containing a suitable amount of a finely divided inert inorganie filler, (Pr -c _ and then drying and baking said final coating for a timie and at a temperature sufficient to solidify the resin in said ooat-ing but insufficient to produce the com 50 plete curing of said resin in said coating.

The invention will be better understood by reference to the following detailed description anld the accoinpanyilig draw-ing in which the figure represents one type 55 of electrical device which is provided with a moisture-resistanit c(oating in accordance with the process of the present invention.

The power transformer disclosed in the drawing is of the usual type comprising a 60 closed lamilnated (ore 1 with the coil form 2 comlprisin g the primary and secondary windings surrounding one leg of the core ltald with the (oil 2 c ompletelv surrounded b)y a spiral lrwrapping 3 of an insulating 65 tape of muslin, for exanmple.

The p)resen 1 t invention is concerned with the provision of a moisture-resistant coat-ing for sucm a device, which coating will be'substantially imoisture-proof even when 70 the device is subjected to water immersion anird which will maintain its moisture-resistant properties over a wide tempera-ture range, such as from 50 V C to + 125 ' C 76 The preferred proc(edure for applying a moisture-resistant coating to a trans-former of the type diselosed in the draw-ing K will now be described.

l Irr REGNAT ro B 80 After the transformer has been thoroughly dried by baking in lt vacuum for several hours at a temi)erature of 23 Os F the transformer is immediately placed in an unheated tank an 1 d main 85 tamied under a vacunum while cooling from the baking temperature An impregnatinog coll) ounld comprising a p)olylierizal)le varnish, is then drawn into the tank to cover the transformier completely while 90 still inaintaining a vacuullm in the tank.

W,892 642,892 The vacuum in the tank is maintained for several minutes after which the vacuum is broken and the tramsformer retained immersed in the impregnating compound S for a further period, forty-five minutes for example The transformer is then removed from the tank, is air dried and drained at room temperature for one hour and is then baked at a temperature of 27 W O F for 8 to 10 hours, or until the polynmerizable material in the inipregnitting, compound is substantially fully cured Thie impregnated transformer is then allowed to cool in the evacuated tank after which the transformer is given a second impregnia-tion with the same impregnating comi-pound in accordance with the same pro-cedure described for the first impregna-tion including, as a final step, balking at 2 () the same temperature and for the same length of time.

COATING.

The doubly impregnated transformer is then given two coatings of a uniform mix-Z 5 ture of a coating compound, comprising a polynierizalble varnish and finely divided talc (magnesium silicate) in the propor-tions of 3 5 pound S of talc to 4 1 pound 1 S of the resin content of the varnish.

The impregnated transformer is first completely immersed in the coating (coin)- pound, for it substantial period and for at least ten minutes alter which the trans-former is withdrawn, drained and air dried at room temperature for 5 or 6 hours, followed by slowly baking the coated transformer for a period of o hours at a temperature of 2 09 F + 100 F.

The coating transformer is again com-pletely immersed in the coating compound for at least ten minutes after which it is withdrawn, drained and air dried at room temperature for 5 or 6 hours, followed by slowly baking the coated transformer for a period of 11 to 12 hours at a temperature of 2009 F + 10 ° F.

The period of air drying at substantially room temperature prior to the baking at an elevated temperature is desirable to facilitate the evaporation of the thinner or solvent of the varnish before the coating compound has become hardened The rela-tively slow rate Qf partial curing of each coating is desirable to complete the driving eff of the volatile thinner at such a slow rate as to prevent the formation ill the coating of voids or holes which if pre-sent would result in reduced resistance of the structure to moisture penetration.

It is preferable that the same varnish lie used as the impregnating compound and in the eoating compound One varnish which has been found quite satisfactory for both the impregnating compound and the coating compoundl is "Harvell 612 C" 65 varnish manufactured by the Irvington Varnish and Insulator Company This commercial varnish maty be used un-changed in the coating compbound but it aill generally lie found advisable to add 70 a small amount of thinner, such as petroleum naplitha, to the varnish when it is to be used as the imnpregnating coii-pound This Harvel varnish comprises the condensation product of formaldehyde 75 and the oil of the caslhew nut shell (which contains a phienioli(c-lilke component) dis-solved in a suital)le solvent, such as petroleum naptlha, the varnish having a solid content of 57 per cent + 2 per cent 80 However, other heat reactive polyvneriz-able varnishes having a low oxidation rate when exposed to air may be employed in the process of this invention.

Purified tale is the preferred finely 85 divided inert inorganic filler to be a(l(led to the varnish to forni the coating ( O on-poun(l The tale imiay be either fibrous or amorphous although the amorphous formi is preferred G(-lod resu lts ixave been 90 obtained when tlhi talc is such that it will pass through a 200 mesh sireen, I nited States standard spei ification Tale is par-ticularly advantageous because of its low tempierature coefficient of expansion, and 95 because its relatively low densitv enables it to be uniformly suspended ill the varnish Tale is also desirable beeause of its good wetting characteristies in varnish anl(d its poor wetting characteristics in 100 water However other finely divided inert powders of low temperature co-efficient of exp lsioil may be employed in place of talte, sueh as sand, mica, asbestos, aluminiiiumil silicate and chlalk 100 In order to achieve tile best results in making the coated transformer moisture-resistant, it has been found that the amount of tale employed in the e(oating compound is soinewliat critical It is pre 110 ferred that the varnish and the tale be mixed in such l oportioiis that the weight of the tale is S-; per cent of the weighlt of the solid content of the varnish However good results will le obtained i} the weight 11; of the talc lies within the range from SO per cent to 90 per cent of the weight of the solid content of the varnish In ayll event, the weight of the talc used in tie - Coatillg collmpound should be less than the 120 weight of the solid oilntent of the varnish.

The amount of the inert filler employed in the coating (compounld depends upon the density of the filler When the followini.

fillers are used in the eoatiing nomnloundi 125 in place of tale the weight of each substi-tuted filler in the mixture as compared to the weight of the solid content of the varnish should be as follows:- Per cent teristics even when subjected to such wide temperature variations that would cause 65 a fully cured coating to crack.

to 93 In order to distinguish more clearly to 10 U from the partial curing of the varnish-88 to 98 filler coating and the full curing of the varnish impregnations, it may be stated 70 to 90 that for each varnish-filler coating the 88 to 9 S baking is for a time and a temperature such that the coating while solid is still iat the con thermoplastic, the resin has not reached coating mix the stage of infusibility and the resinous 75 roducing the material is still soluble in its original coating coim solvent; while for the full curing in the referred con impregnations the varnish is made in-econds when fusible, is no longer thermoplastic and is ) with a O 20 insoluble iln its original solvent 80 h A S T M After the transformer has had applied lear lacquers thereto two coatings of the varnish-filler shed ill 1942 mixture a subsequent inspection will dis-ty of Testing close no line of demarcation between the f the thinner first coating and the second coating The 85 ated or addi two coatings appear as a single coating this re(quire alld it is impossible to strip oft the second coatiiig from the first coating Since at ins and the the time the second coating is applied the loyed depend resin in the first coating is still in a par 90 eonfiguration tially soluble state, it is likely that the and the tem surface of the first coating is softened evice may be somewhat by the solvent in the second a small size coating to co 6 alesce the two coatings into a imenesions of unitary coating as the result of the final 95 nchles of the baking.

awing, it has It has also beeii found preferable to apregnations achieve the partial curing of the resin in sirable when the coating conipound at a relatively slow at the device rate, that is, by using a relatively low 100 ire proofing laking temperature for a (considerable temnl)erature lengthi of time rather than by baking at a to +'12 A-3 ° C higher temperature for a, shorter time In -are found 1)articular for the first coating of varnish o should be andl talc the preferred baking is at a tem 105 d for a time perature of 19 W O F for a period of 5 hours, above in the although the same anmount of partial than the one curing M-ay be obtained at a baking tem-two coatings perature of 180 F for 8 hours or at a Yen for small baking temperature of 210 ° F for 4 hours 110 tings may be For the final coating of varnish and talc r instalnces to the preferred baking temh)erature is re resistant 190 F for a period of 12 hours although the same amount of partial curing may be the baking attaiaed at a bakting teniperature of 1800 116 is that while F for a period of 1,5 hours or a baking -levice in the temperature of 2109 F for a period of 10 1 y cured, the lhours, anld a proportionate number of ating steps is hours for other temperatures between s, the baking 2100 F and 1800 F 120 ttion of the It should also be noted that each coat-such that the ing applied prior to the final coating is is only par baked for a much shorter length of tilne flexible coat than the final coating; this is because the tings are pro bakling of the final coating also increases 125 ags produced the amount of curing of the earlier coat-is been found ings and the total baking to which an istant eharae inner coating is subjected should not be Finely divided sand or silica Finely divided mica - Finely divided asbestos - Finely divided aluminium silicate Finely divided chalk - It has also been found tlh sisteucy of the varnish-filler ture is somnewhiat critical in pm best results At the time the pound is ready for use, its pi sistency is of 49 seconds + 4 s measured in ain A S T M cur inch, hole in accordance wit method D-333 for testing cl and lacquer enamels as publi in Part II of Americall Sociel Materials Standards Part o:

in the varnish may he evapor tioual thinner added to meet mle iit.

The number of imupregnati number of coditings to be empl somewhat upon the size anbrd of the device to be protected -perature ranlrge to which the d subjected in service With transformer having over-all cl 4 inchles by 4 inchles by 4 i configuration shown ini tlbe dr been foundl that multiple i T and multiple coatings are de the requirements are such th must illailntaill its mlooisti characteristics over a wide range, sutch as from 55 ° C.

If more than two coatinp, desirable, the final coatin baked at time temperature an interval the same as specified first coatingi For coils larger assumed above, more than will generally be desirable; e size coils more than two coal found advantageous in malny obtain increased mnoistu:

characteristics.

An important feature of treatments above described the varnish applied to the two impregnating steps is ful varnish applied in the two co only partially cured; that ih temperature and( the dura baking for each coating are iesin content of the coating tially polymerized whereby ings and not hard brittle coa duced With flexible coatii in this imanner, the device hi to maintain its moistmre-resi 6492,892-sufficient to fully cure the resin of the inner Coating.

The transformer disclosesd in the draw-ing illustrates the device af'ter it has been subjected to two impregnation-s followed bv two coatin-s as describe(d earlier in this specification It is assumed that the varnish aplplied to the first impregnation is almost entirely absorbed by the coil form 2 and the muslin tape 3, while form-iln a thin coating 4 oil the metal core 1.

For the second impregnation it is assulle(l that not all of the varnish is absorbed by the coil but some of it forms a coating external to the muslin tape 3 The inner coatin aud the outer coating of the varnish-talc mixture are indicate(d bv the reference characters 6 and 7 The O various terminals 8 for the tranis-former are sl ownl after the varnish and( varnishl-talc coattii"gs thereon have been removed It is of ecoxise to be un(ler-stoodi that in the drawing tile thickness of-each varnlishl or varnxisli-tale coatin-g has been soniewlat exaggerated Frolli the disclosure in the drawing it will be apparent that the smooth glassy-like moisture-lproof coating produced bv this inveiltion extends not only around thie coil of the transformer but also compll)letely covers all metal p Jarts of the transformer allld lea(ls, i'esutltimii ill a coltin(ous coat-ing;iirroiinding the wlhole structure.

Raving now paticublarly,(lerilleil and ascertained the nature of our said inven-tion and in wvhat manner the samie is to lie J)erforlme(l, we declare that what wve cla illa L is:- 1 The metllool of forming a smootlh 4 d' adllerenit inoisture-resistallt coatillg On a surface such at S the external surface of an electri (cal (levi(ce coilpl)risii t a forme(d (voil, wlhich mletilod comprises applying to the surface,au impregnating colting conlsist-ing of a polymierizable resin varnish, dry-illg and baking said inipregpation coatiiig until the varnish is substantially fully Cured, subsequeltly ajiplynig to tile sur-face a final coatin g of a polvinerizable resin varnish contaillillg a suitable amount of a finely divide(d inert inorganic filler, and thneli drying anird baking said final coatillg for a timne and at a tempera-ture sufficient to solidify tile resin in sai(i coating but insufficielit to produce the conmiplete curing of said resill in said (coat-ing.

42 The metilod according to calaiii l in wlhich the filler of the final coatino is filnelv divided talc combine(d with the resin varnish in such relative proliortions tlat tile weight of the ttalc is 80 per eent, to 90 per cent of the weight of the solid content of the varnisl.

3 The method according to claims 1 or 65 in which the final coating is dried at sub-stalltially room temperature and then baked at a temperature of 180 ' F to 210 ' F for a time of fifteen hours for a tem-perature of 18 (l W F_ of ten hours for a 70 temperature of 210 ' F and a propor-tionate number of hours for a tenlperature between 21 ( 30 F and 1800 F.

4 The method according -to any of claims I to 3 ill whiclh the impregnating 76 coating c omuprises a solution of the reactioll prodilet of a cashew nut shell oil andl an aldellyde and is dried and baked at a tenmierature of 2 O ') F for a time of eight to ten hours s ; The niethold according to lill V of clliins 1, '2

and 4 in which tile finlal coat-ing of varnish 1 N 1 ( 1 talc is applied ill two layers, the first layer being dried at room teiiiperature and then bakled for a period 85 of five lhours at a temperature of 190 ° F.

to 21 ( O ' F_, tile second layer being dried at 1 r 0011 temperature and then baked for a lperio(l of tell to twelve Ilours at a telilpera-ture of 19 ( O ' Fto 219 ( F 90 6 A device llavillg a surface coated by tile method according to clainl 1 witll ai inner impregnating coating, of a resin cured to an illfuhsible insoluble state and nll outer coatilln of aln illcompletely 95 thlerllmally cured resin conltaining a finely (liviide(l inlor-allie filler.

7 A device Coml)letely encased ill a pro-tective resinous coatinlg oln its external sur-face produced b)y the method accordillg to 100 clainl 1 reniderinlg it resistallt to illoisture pelletration even aflter exposure to widely varyilng telllperatures, sai(l resinous (eoat-in comp olrising all illnler impregnating laver of a polymnerizable resin polyllierized 105 to an infusible stalte alld an outer coating of a p)olymerizai)le resill ilaving dispersed tlleretllhougll a finely divided inorganic filler ill an aniount not greater than the weight of the resin ill said outer coatillg li O but miot less than 80 per cent by weigilt of tile resin in said outer coatinlg, said outer resill coating being thermlally cured to a state ill which it is flexible solid but is still fusible 116 8 Methods of coatin surfaces substan-tially tl S herein described.

Dlated this 1 st day of August, 194 G.

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